

What is claimed is:

SUB A17

1. A database system comprising:
one or more storage devices containing a table having plural rows,
the plural rows including a first row containing a before image
representing data before a data modification operation and a second row containing an
after image representing data processed by the data modification operation.

2. The database system of claim 1, wherein the one or more storage devices
further contain identifiers to identify a state of each row.

3. The database system of claim 2, wherein the identifiers are contained in
the table.

4. The database system of claim 1, wherein the first and second rows are
associated with the same row identifier. *no out for "row identifier"*

5. The database system of claim 4, wherein the table further contains state
identifiers to identify a before image state of the first row and an after image state of the
second row. *object id*

6. The database system of claim 1, wherein the data modification operation is
performed in a transaction, the transaction having one or more requests, wherein the first
row contains a transaction before image representing data before the beginning of the
transaction, and wherein the plural rows further comprise a third row containing a request
before image representing data before the beginning of a request in the transaction.

7. The database system of claim 5, further comprising a module adapted to
transition the state of each row based on a data manipulation command.

log the operation

1 8. The database system of claim 1, further comprising a module adapted to
2 return data in the second row in response to a read request under a normal condition.

provisionally updated flag indicating modification to object

1 9. The database system of claim 8, wherein the module is adapted to return
2 data in the first row in response to a read request under an abort condition in which the
3 modification operation is aborted.

1 10. The database system of claim 9, further comprising a rollback module
2 adapted to mark the first row as containing a current image in response to the abort
3 condition.

1 11. The database system of claim 10, wherein the rollback module is adapted
2 to further remove the second row in response to the abort condition.

1 12. The database system of claim 1, wherein the table contains a first row
2 identifier associated with the first and second rows, a first state identifier having a first
3 value associated with the first row, and a second state identifier having a second value
4 associated with the second row.

1 13. The database system of claim 12, wherein the table further contains a
2 mutation identifier associated with the first row identifier to identify that the modification
3 operation is occurring with respect to one or more rows associated with the first row
4 identifier.

1 14. The database system of claim 13, wherein the mutation identifier changes
2 value with each new modification operation.

1 15. The database system of claim 14, wherein the data modification operation
2 is performed in a transaction, each transaction having one or more requests, the mutation
3 identifier having a transaction identifier portion and a request identifier portion.

1 16. The database system of claim 15, wherein the transaction identifier portion
2 has a value that increments with each new transaction.

1 112 17. The database system of claim 14, further comprising a module adapted to
2 return a row to return based on the mutation identifier and state identifier information.

1 18. The database system of claim 14, wherein the one or more storage devices
2 further contain an active mutation identifier list having one or more mutation identifiers
3 associated with one or more active modification operations.

even one mutation identifier is a list

1 19. The database system of claim 18, wherein the one or more storage devices
2 further contain an abort mutation identifier list having one or more mutation identifiers
3 associated with one or more aborts of modification operations.

1 20. A method of providing access in a database system, comprising:
2 storing data in rows of a table; and
3 in response to a data modification operation of a first row, marking the
4 first row as a before image row containing data before the start of the data modification
5 operation, and creating a second row as an after image containing data processed by the
6 data modification operation.

1 21. The method of claim 20, further comprising setting a first state identifier
2 to a first value to identify the first row as the before image row and setting a second state
3 identifier to a second value to identify the second row as the after image row.

1 22. The method of claim 21, further comprising returning the second row in
2 response to a read operation under a first condition.

112 second row never removed

first row never returned
3

23. The method of claim 22, further comprising returning the first row in response to the read operation under a second condition in which the data modification operation has been aborted.

1 24. The method of claim 20, further comprising rolling back to the first row if
2 the data modification operation aborts.

1 25. The method of claim 24, further comprising deleting or marking as
2 available for reuse the second row during a rollback process in response to the abort.

1 26. The method of claim 20, further comprising marking the second row as a
2 current row if the data modification operation commits.

1 27. The method of claim 26, further comprising deleting or marking as
2 available for reuse the first row once the data modification operation commits.

1 28. An article comprising at least one storage medium containing instructions
2 that when executed cause a system to:
3 store data in rows of a table; and
4 store a state identifier associated with each row, the state identifier having
5 a first value to indicate a row as being a before image of a data modification operation
6 and a second value to indicate a row as being an after image of a data modification
7 operation.

1 29. An article comprising at least one storage medium containing:
2 a data structure having plural portions,
3 the data structure further containing state identifiers associated with
4 corresponding portions, a first state identifier having a first value to indicate a row as
5 being a before image of a data modification operation and a second state identifier having
6 a second value to indicate a row as being an after image of a data modification operation.

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